Compositional engineering of glass/ceramic composites for low temperature co-fired ceramic applications

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Thin, lightweight and multifunctional electronic components are attracting considerable attention due to the rapid growth of wireless communication systems and microwave devices such as those used in the automotive, medical and telecommunication. Low temperature co-fired ceramic (LTCC) technology allows manufacturing of 3D ceramic modules with embedded components and metal electrodes. LTCC applications require densification at temperatures lower than 950 °C to allow co-firing with metal electrodes, lower dielectric constant to increase signal transmission speed, a thermal expansion coefficient matched to Si for reliability and higher thermal conductivity to dissipate heat. For this purpose, (SiO_2–Al_2O_3–CaO)-based glass /ceramic (mullite or Al_2O_3) composites with AlN or hBN nano fillers were investigated. High sintering temperatures of Al_2O_3 and mullite ceramics were decreased by means of viscous sintering of the glass phase. Nano fillers were particularly added to improve thermal conductivity of the composites. The composites were fabricated by tape casting method. XRD results proved that nano fillers neither chemically reacted with the other phases nor decomposed with temperature, which was critical to increase thermal conductivity and at the same time to decrease dielectric constant. In general, high thermal conductivity comes with high dielectric constant for the commercial products but high dielectric constant limits faster signal transmission speed. Therefore, in this presentation, a systematic methodology to optimize dielectric, thermal and mechanical properties will be explained by means of compositional engineering of the glass/ceramic composites.